



# More standing and just as productive: Effects of a sit-stand desk intervention on call center workers' sitting, standing, and productivity at work in the Opt to Stand pilot study

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## ABSTRACT

This study evaluated the effects of sit-stand desks on workers' objectively and subjectively assessed sitting, physical activity, and productivity. This quasi-experimental study involved one intervention group ( $n = 16$ ) and one comparison group ( $n = 15$ ). Participants were call center employees from two job-matched teams at a large telecommunications company in Sydney, Australia (45% female,  $33 \pm 11$  years old). Intervention participants received a sit-stand desk, brief training, and daily e-mail reminders to stand up more frequently for the first 2 weeks post-installation. Control participants carried out their usual work duties at seated desks. Primary outcomes were workday sitting and physical activity assessed using ActivPAL or ActiGraph devices and self-report questionnaires. Productivity outcomes were company-specific objective metrics (e.g., hold time, talking time, absenteeism) and subjective measures. Measurements were taken at baseline, 1, 4, and 19 weeks post-installation. Intervention participants increased standing time after 1 week ( $+73$  min/workday (95% CI: 22, 123)) and 4 weeks ( $+96$  min/workday (95% CI: 41, 150)) post-intervention, while control group showed no changes. Between-group differences in standing time at one and 4 weeks were  $+78$  (95% CI: 9, 147) and  $+95$  min/workday (95% CI: 15, 174), respectively. Sitting time in the intervention group changed by  $-64$  (95% CI:  $-125$ ,  $-2$ ),  $-76$  (95% CI:  $-142$ ,  $-11$ ), and  $-100$  min/workday (95% CI:  $-172$ ,  $-29$ ) at 1, 4, and 19 weeks post-installation, respectively, while the control group showed no changes. No changes were observed in productivity outcomes from baseline to follow-up in either group. Sit-stand desks can increase standing time at work in call center workers without reducing productivity.

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## 1. Introduction

The workplace is a key setting for health promotion (WHO/WEF, 2008) but has become increasingly sedentary over the past 50 years (Church et al., 2011). High levels of sedentary behavior are associated with adverse health outcomes, such as cardiovascular disease, diabetes, and all-cause mortality (Wilmot et al., 2012; Proper et al., 2011; van Uffelen et al., 2010), and this association is only partially moderated by physical activity (Chau et al., 2013). It is important to develop strategies

to address sedentary behavior in occupations in which workers sit for prolonged periods of time.

Workers in desk-based roles have high occupational sitting time (Parry and Straker, 2013; Thorp et al., 2012). While using sit-stand desks has shown promising results for reducing sitting time in the short term (Neuhaus et al., 2014a; Torbeyns et al., 2014; Neuhaus et al., 2014b; Chau et al., 2014a), their effects on productivity have been equivocal (Karakolis and Callaghan, 2014). For example, Pronk et al. (2012) found that office workers in a health promotion unit reported feeling more productive, energized, focused, and less stressed, as a result of working with sit-stand workstations. On the other hand, Husemann et al. (2009) asked male university students to complete a data entry task in a laboratory-based sit-stand workstation simulation and found small non-significant reductions in data entry efficiency and accuracy while standing compared

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to sitting. Such conflicting findings are perhaps related to the fact that previous studies have involved selected samples (e.g., university setting, health-related organization) (Neuhaus et al, 2014b; Pronk et al, 2012; Alkhajah et al, 2012; Chau et al, 2014a) and relied on self-report assessments or objective outcomes as determined by laboratory-based tasks in order to assess productivity impacts in response to reduced sitting time (Neuhaus et al, 2014a; Karakolis and Callaghan, 2014).

Taken together, little is known about the impact of sit-stand desks on actual worker productivity in a real-world setting. This is an evidence gap which needs to be addressed before organizations invest in sit-stand desks as a measure for preventing chronic disease and promoting wellness in their workforce. Thus, this study examined the effects of using sit-stand desks on call center workers' objectively and subjectively assessed productivity, as well as sitting and physical activity, over 19 weeks.

## 2. Methods

### 2.1. Study design

This study had a quasi-experimental design involving one intervention group and one comparison (control) group. We collected data between May and September 2013. This study was approved by the Southern Cross University Human Research Ethics Committee (ECN-13-010).

### 2.2. Participants

Customer care (call center) staff from two teams working at one worksite of a large telecommunications company in Sydney, Australia, were invited to join this study. The research team gave a presentation about the study to team leaders and managers, who then discussed the study with their staff. Participants joined the study by returning a signed consent form to the researchers. One team was assigned *a priori* to the intervention condition, while the other was assigned to the control condition. Both teams carried out similar duties and were located on separate levels in the same building. Participants were not blinded to their condition allocation.

### 2.3. Intervention

Participants in the intervention team each received a sit-stand desk (Rumba "2 Stage" Sit-Stand Workstation from Zenith) and brief training on its use, and daily e-mail reminders to stand up more during the workday for the first 2 weeks after sit-stand desks were installed. Participants in the control team continued their work as usual, using their regular desks.

### 2.4. Procedures

We collected objective and self-reported data from all participants about their work and non-work sitting and physical activity, as well as productivity, at four time points: at baseline (before sit-stand desk installation, Week 0), 1 week after sit-stand desk installation (Week 1), 4 weeks after the installation (Week 4), and 19 weeks after the installation (self-report only for sitting and physical activity outcomes) (Week 19). Participants wore an accelerometer (ActivPAL or ActiGraph) during each measurement week and kept a monitoring log book to track their device wear time while at work. Participants also completed an online questionnaire (SurveyMonkey Inc Palo Alto, California, USA) at the end of each measurement week via a unique link e-mailed to each participant individually. Test periods ran from Monday to Saturday. A research member delivered the accelerometers and log books to participants the week prior to the measurement period, and collected them on completion.

### 2.5. Sitting and physical activity measures

We used two types of devices for the objective measurement of physical activity in this study. Half of the participants in each group wore an ActivPAL inclinometer, while the other half wore an ActiGraph accelerometer. ActivPAL and ActiGraph devices were evenly distributed across the two study groups and participants were provided with the same type of monitor at each measurement time point. Participants also recorded their device on and off times in a monitoring log book at each time point. Activity during work hours was determined by temporally linking ActivPAL and ActiGraph data to the work times recorded in participants' monitoring log books.

The ActivPAL (model ActivPAL3; PAL Technologies Ltd., Glasgow, UK) is a small lightweight monitor worn on the front mid thigh that measures postural information by identifying periods of lying down, sitting, standing, and stepping based on the inclination of the thigh (Grant et al, 2006; Ryan et al, 2006). This device has demonstrated reliability and validity for measuring posture and activities of daily living (Grant et al, 2006). We processed ActivPAL data first using proprietary software (activPAL v6.1.2.17; PAL Technologies Ltd., Glasgow, UK), which classified the data into sitting, standing, and stepping categories, and then we used custom software (HSC analysis software v2.19, Philippa Dall and Malcolm Granat, Glasgow Caledonian University) to isolate participants' work time data based on their work start and finish times as reported in their monitoring log.

The ActiGraph (model GT3XP; ActiGraph, LLC, Fort Walton Beach, FL) is a commonly used triaxial accelerometer for objective monitoring of time spent in different physical activity intensity levels, including sedentary time. It was worn on the right hip during work hours. It has demonstrated validity and reliability for measuring free-living physical activity (Santos-Lozano et al, 2012). ActiGraph data were processed using Actilife v6.6.3 (LLC, Fort Walton Beach, FL). Bouts of 60 min or more of consecutive zeroes were considered as non-wear time while allowing two interruptions in the zeroes between 1 and 100 counts/min. We calculated time spent in sedentary (<100 counts/min), light (100–2019 counts/min), moderate (2020–5998 counts/min), and vigorous-intensity activity (>5999 counts/min), using established cut points for adults (Troiano et al, 2008).

In addition to the above-mentioned objective measures of sitting and physical activity, we assessed time spent sitting, standing, walking, and doing more physically demanding tasks at work with the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) (Chau et al, 2012). This self-report questionnaire has demonstrated test-retest reliability and validity for assessing sitting and standing against ActiGraph and ActivPAL devices (Chau et al, 2012; Van Nassau et al, 2015). The OSPAQ also has good responsiveness to change for measuring changes in sitting and standing time (responsiveness to change index for sitting =  $-1.39$  and index for standing =  $1.75$ ) (Van Nassau et al, 2015).

We estimated leisure time physical activity using the self-reported Active Australia Questionnaire, which consists of six questions assessing the frequency and duration of walking, moderate-, and vigorous-intensity physical activity in the past 7 days. This instrument has demonstrated better reliability and validity than Behavioral Risk Factor Surveillance System (BRFSS) and International Physical Activity Questionnaire (IPAQ) measures among adult Australians against ActiGraph accelerometers (Brown et al, 2004a; Brown et al, 2004b).

Participants also self-reported their sex, age, height, weight, employment status (full time or part time, number of days worked, and hours worked per week, and highest level of education).

### 2.6. Productivity measures

All productivity measures were specified and provided by the company to cover the same period as the sitting and physical activity measurements. Objective productivity indicators were call handling time,

time spent talking, time spent on hold, time spent wrapping up call, attendance, and sick leave. Subjective productivity was assessed by asking participants to respond to a set of statements about their work-related perceptions, energy, and feelings using a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). The statements were as follows: “The physical working conditions at my location are satisfactory,” “I am able to sustain the level of energy I need throughout the work day,” “I feel positive at work most of the time,” and “There are no substantial obstacles at work to doing my job well.” These statements were provided by the company’s workplace wellness team for the purposes of this study.

## 2.7. Analyses

We analysed the data using SAS software (Version 9.3, Windows SAS system). A linear mixed model was used to calculate adjusted means for the outcomes at each measurement time point. This model was necessary to accommodate the small sample size and missing data as a result of absent participants at various times of data collection, as well as some faults in activity monitors. The fitted fixed effects included group (intervention or control), measurement time point, interaction between groups, and measurement time point. Participant ID was fitted as a random effect to take into account repeated measures on the same participant at different times. ActiGraph and ActivPAL data were considered valid when the device was worn at least 75% of monitoring time (van der Ploeg et al, 2010). Analyses of ActivPAL outcomes involved participants with valid data, and at least 2 days of work for full-time employees or at least one work day for part-time employees (Chau et al, 2014a).

## 3. Results

Due to the low amount of objective sitting and physical activity data collected arising from low participant adherence to activity monitor use and device malfunction, we present the more complete and informative self-reported sitting and physical activity results here in the main part of this paper. Results from the objective monitoring are presented in Supplementary Tables S1 and S2.

Fig. S1 shows the flow of participants through the stages of the study. At baseline, intervention and control groups had a similar proportion of men and women, and full-time and part-time staff (Table 1). On average, the intervention group had higher BMI, less previous experience

with using a sit-stand desk, and a greater proportion of people meeting physical activity recommendations, compared to the control group (Table 1).

### 3.1. Effects on occupational sitting and physical activity

Participants in the intervention group reported significantly reduced sitting time (−64, −74 and −100 min per workday at Weeks 1, 4, and 19, respectively), while the control group showed no significant changes, albeit the differences between groups were non-significant (Table 3). The reduction in sitting time at work appeared to be mostly due to increases in standing time. Indeed, participants in the intervention group reported significant increases in standing time by +73 and +96 min per workday at Weeks 1 and 4, respectively, but not at 19 weeks, and these changes were significantly different to those observed in the control group (Table 3). Occupational time spent walking or doing physical tasks did not change significantly in either study group. Objectively assessed sitting and physical activity results showed non-significant changes in sitting, sedentary, and standing time (Supplementary Table S2).

### 3.2. Effects on productivity

At the Weeks 1, 4, and 19 measurement time points, there were no significant changes from baseline in objectively measured productivity outcomes (Tables 2 and 3). Talk time on call, hold time on call, wrap up time on call, average call handling time, attendance days, sick days, or customer ratings in both the intervention and control groups did not change significantly, and there were no significant differences between groups for any of these parameters. Participants in both the intervention and control groups rated their work perceptions, work-related energy, and feelings at work positively at all measurement time points (Table 4). There were non-significant trends toward more positive work perceptions among the intervention group, while this was not evident in the control group. The intervention group expressed significantly stronger agreement at Week 19 than at baseline that they were able to sustain their energy levels throughout the workday.

## Discussion

The results of the Opt to Stand study demonstrate that providing sit-stand desks for customer care (call center) workers can increase

**Table 1**  
Participant characteristics at baseline in the Opt to Stand Study, Sydney, Australia.

Characteristic		All Mean (SD) or count (%)	Control Mean (SD) or count (%)	Intervention Mean (SD) or count (%)
N		31 (100%)	15 (48%)	16 (52%)
Sex	Female	14 (45%)	7 (47%)	7 (44%)
	Male	17 (55%)	8 (53%)	9 (56%)
Age		33.0 (10.8)	35.1 (11.5)	31.0 (10.0)
BMI (kg m <sup>−2</sup> ) <sup>a</sup>		26.8 (5.5)	26.0 (4.9)	27.7 (6.3)
BMI category <sup>a</sup>	Normal range (18.5–24.9)	7 (41%)	4 (44%)	3 (38%)
	Overweight (25.0 – 29.9)	7 (41%)	3 (33%)	4 (50%)
	Obese (≥30.0)	3 (18%)	2 (22%)	1 (13%)
Work status	Full time	25 (81%)	13 (87%)	12 (75%)
	Part time	6 (19%)	2 (13%)	4 (25%)
Education	Some high school	5 (16%)	2 (13%)	3 (19%)
	Completed high school	7 (23%)	4 (27%)	3 (19%)
	Trade/technical certificate or diploma	6 (19%)	4 (27%)	2 (13%)
	University	13 (42%)	5 (33%)	8 (50%)
Used sit-stand desk before <sup>a</sup>	No	11 (69%)	5 (56%)	6 (86%)
	Yes	5 (31%)	4 (44%)	1 (14%)
Physical activity <sup>a,b</sup>	Insufficient	5 (31%)	4 (44%)	1 (14%)
	Sufficient	11 (69%)	5 (56%)	6 (86%)

<sup>a</sup> Data missing for BMI (n = 14), previous use of sit-stand desk (n = 15), physical activity (n = 15).

<sup>b</sup> Sufficient physical activity was defined as engaging in at least 150 min per week of moderate-to-vigorous physical activity on at least 5 days of the week.

**Table 2**

Mean (SD) self-reported occupational sitting and physical activity, and objective productivity indicators at baseline, 1, 4, and 19 weeks post-installation of sit-stand desks (intervention) in the Opt to Stand Study, Sydney, Australia.

Outcome	Control				Intervention			
	Baseline, mean (SD)	1 week, mean (SD)	4 weeks, mean (SD)	19 weeks, mean (SD)	Baseline, mean (SD)	1 week, mean (SD)	4 weeks, mean (SD)	19 weeks, mean (SD)
<i>Self-reported occupational sitting and physical activity (per workday)</i>								
Percent time sitting at work <sup>a,b</sup>	74 (14)	76 (13)	73 (14)	78 (10)	70 (13)	58 (17)	54 (18)	59 (18)
Percent time standing at work <sup>a,b</sup>	11 (7)	11 (8)	13 (6)	10 (7)	10 (6)	25 (18)	30 (18)	24 (12)
Percent time walking at work <sup>a,b</sup>	13 (8)	12 (5)	12 (5)	12 (5)	16 (7)	14 (7)	14 (8)	11 (6)
Percent time heavy lifting at work <sup>c</sup>	1 (3)	2 (3)	3 (5)	1 (2)	4 (4)	2 (3)	3 (8)	7 (12)
Sitting at work (min per workday) <sup>a,b</sup>	371 (86)	348 (69)	332 (73)	354 (99)	353 (81)	277 (77)	260 (84)	239 (98)
Standing at work (min per workday) <sup>a,b</sup>	54 (31)	49 (38)	56 (25)	42 (34)	50 (31)	124 (93)	147 (84)	104 (64)
Walking at work (min per workday) <sup>a,b</sup>	68 (40)	54 (23)	53 (21)	53 (27)	78 (35)	69 (35)	70 (46)	52 (33)
Heavy labor at work (min per workday) <sup>c</sup>	7 (16)	8 (15)	15 (23)	2 (4)	20 (22)	11 (13)	16 (48)	32 (56)
<i>Objective productivity indicators</i>								
Talk time on call (min per call) <sup>d,e</sup>	5.3 (1.5)	5.3 (1.4)	5.4 (1.6)	4.8 (2)	5.5 (2)	5.4 (1.6)	5.5 (1.5)	5.4 (0.58)
Hold time on call (min per call) <sup>d,e</sup>	1.3 (0.8)	1.2 (0.8)	1.1 (0.7)	1.2 (0.63)	1.5 (0.5)	1.7 (0.9)	1.7 (0.7)	1.8 (0.41)
Wrap up time on call (min per call) <sup>d,e</sup>	5.3 (1.2)	5.9 (1.7)	6.4 (1.8)	6.5 (1.9)	5.8 (1.5)	5.8 (1.5)	6.3 (2.1)	5.5 (1.6)
Average call handling time (min per call) <sup>d,f</sup>	11.9 (2.9)	12.4 (3.2)	12.9 (3.1)	12.8 (3.39)	12.8 (1.8)	12.6 (2.4)	13.5 (2.6)	13.4 (2.2)
Attendance (days) <sup>d,g</sup>	4 (1)	4 (1)	5 (1)	5 (0)	4 (1)	4 (1)	4 (1)	4 (1)
Sick leave (days) <sup>d,h</sup>	0.7 (0.8)	0.5 (1)	0.3 (0.6)	0 (0)	0.2 (0.7)	0.4 (1.3)	0.1 (0.3)	0 (0)
Customer rating (%) <sup>i,j</sup>	69 (12)	44 (38)	48 (26)	59 (30)	60 (19)	51 (29)	71 (34)	63 (37)

<sup>a</sup> Sample sizes for control group: baseline ( $n = 11$ ), 1 week ( $n = 12$ ), 4 weeks ( $n = 6$ ), and 19 weeks ( $n = 8$ ).

<sup>b</sup> Sample sizes for intervention group: baseline ( $n = 8$ ), 1 week ( $n = 14$ ), 4 weeks ( $n = 10$ ), and 19 weeks ( $n = 7$ ).

<sup>c</sup> Sample sizes for intervention group: baseline ( $n = 8$ ), 1 week ( $n = 14$ ), 4 weeks ( $n = 10$ ), and 19 weeks ( $n = 6$ ).

<sup>d</sup> Sample sizes for control group: baseline ( $n = 7$ ), 1 week ( $n = 11$ ), 4 weeks ( $n = 11$ ), and 19 weeks ( $n = 11$ ).

<sup>e</sup> Sample sizes for intervention group: baseline ( $n = 7$ ), 1 week ( $n = 15$ ), 4 weeks ( $n = 12$ ), and 19 weeks ( $n = 10$ ).

<sup>f</sup> Sample sizes for intervention group: baseline ( $n = 7$ ), 1 week ( $n = 14$ ), 4 weeks ( $n = 12$ ), and 19 weeks ( $n = 10$ ).

<sup>g</sup> Sample sizes for intervention group: baseline ( $n = 9$ ), 1 week ( $n = 15$ ), 4 weeks ( $n = 14$ ), and 19 weeks ( $n = 12$ ).

<sup>h</sup> Sample sizes for intervention group: baseline ( $n = 9$ ), 1 week ( $n = 16$ ), 4 weeks ( $n = 14$ ), and 19 weeks ( $n = 12$ ).

<sup>i</sup> Sample sizes for control group: baseline ( $n = 7$ ), 1 week ( $n = 11$ ), 4 weeks ( $n = 11$ ), and 19 weeks ( $n = 10$ ).

<sup>j</sup> Sample sizes for intervention group: baseline ( $n = 5$ ), 1 week ( $n = 14$ ), 4 weeks ( $n = 11$ ), and 19 weeks ( $n = 10$ ).

standing time at work without negatively affecting their productivity, as measured by objective, organization-specific metrics, and self-report. To the best of our knowledge, this is the first sit-stand desk intervention study conducted in a real-world office setting with objectively assessed and organization-specific productivity outcomes. We found that customer care workers in a call center environment did not show changes in their work productivity as a result of using sit-stand desks, and furthermore, their productivity did not differ from their control condition counterparts, who used “regular” desks. Using sit-stand desks also did not result in differing perceptions about work conditions, energy levels, and positive feelings, although the intervention group did give stronger indication of feeling more sustained energy levels throughout the workday after using sit-stand desks.

Our findings contribute new evidence to the currently mixed literature on the effects of sit-stand desks on productivity and sitting time. Previous research involving objective assessment of productivity have been based on laboratory tasks, such as transcription (Hedge et al, 2005; Ebara et al, 2008) or data entry (Huseman et al 2009), and found either no or small non-significant reductions in productivity (Hedge et al, 2005; Ebara et al, 2008; Huseman et al 2009). In other studies, office workers have reported feeling more productive, efficient, focused, and alert when using sit-stand desks (Pronk et al, 2012; Grunseit et al, 2013; Chau et al, 2014b BMC; Alkhajah et al, 2012). This study also has higher external validity than similar previous intervention studies, which involved selected samples, and so are less useful in producing generalizable evidence to other population groups (Pronk et al, 2012; Alkhajah et al, 2012; Healy et al., 2013; Chau et al., 2014a, 2014b; Neuhaus et al, 2014b). These previous studies were conducted in health-related or university settings with potentially more health-aware workers, and samples consisted of a majority of female and tertiary-educated participants. In contrast, Opt to Stand involved call center workers in a telecommunications company and participants

were mostly male (55%) and had non-tertiary education levels (58%). While Opt to Stand participants were also healthier with respect to BMI and physical activity compared to US workers, they were relatively less healthy than participants in earlier similar studies sampled from mainly health-related organizations, adding to the generalizability of these results. We also observed changes in participants' sitting and standing time after using sit-stand desks, consistent with the literature (Neuhaus et al, 2014b; Chau et al, 2014a; Pronk et al, 2012). Opt to Stand intervention group participants showed a downward trajectory in sitting time and a commensurate increase in standing time across the measurement time points over 19 weeks. These changes are important in light of the evidence about the harms linked to prolonged sitting (Wilmot et al, 2012; Chau et al, 2013) and potential benefits of increasing standing as one way to reduce sitting time (van der Ploeg et al, 2014; Matthews et al, 2015). Our data strongly suggest that sit-stand desks are a feasible option for increasing standing in desk-based workers that can be translated to non-health-related workplaces, in this case, a call center environment.

The findings of this study have implications for evidence-based practice in workplace health promotion and wellness. Organizations considering including sit-stand desks as part of their workplace wellness practice would need to balance the costs associated with purchasing new furniture with that of potential productivity trade-offs. We have added information to one side of this equation by demonstrating that no productivity loss resulted from the implementation of sit-stand desks in this study.

A major strength of this study was the strong engagement with upper level management in the partner organization at all stages of study planning, implementation, and evaluation. This reflected the company's image as being forward-thinking, open to change, optimistic, and person-centric. Clear management support facilitated the logistics of conducting this study: the procurement department liaised with



**Table 3**  
Changes from baseline in self-reported occupational sitting and physical activity, and objective productivity indicators, at 1, 4, and 19 weeks after installation of sit-stand desks (intervention), as well as the difference between intervention and control (no sit-stand desk), in the Opt to Stand Study, Sydney, Australia.

Outcome (per workday)	Weeks post-intervention	Control		Intervention		Difference	
		Estimate	p-value	Estimate	p-value	Estimate	p-value
Percent time sitting at work	1	2 (−9, 13)	0.696	−11 (−23, 1)	0.087	−13 (−29, 3)	0.127
	4	−0 (−14, 14)	0.974	−15 (−28, −2)	<b>0.025</b>	−15 (−34, 4)	0.128
	19	4 (−9, 16)	0.563	−10 (−24, 4)	0.182	−13 (−32, 5)	0.168
Percent time standing at work	1	−1 (−10, 9)	0.889	15 (5, 25)	<b>0.005</b>	16 (2, 29)	<b>0.030</b>
	4	1 (−11, 13)	0.876	20 (9, 30)	<b>0.001</b>	19 (3, 34)	<b>0.026</b>
	19	−2 (−12, 9)	0.775	13 (1, 24)	<b>0.041</b>	14 (−1, 30)	0.084
Percent time walking at work	1	−2 (−6, 2)	0.389	−2 (−7, 2)	0.332	−0 (−7, 6)	0.890
	4	−3 (−8, 3)	0.349	−3 (−8, 2)	0.189	−1 (−8, 7)	0.848
	19	−2 (−6, 3)	0.517	−4 (−9, 2)	0.182	−2 (−9, 5)	0.554
Percent time heavy labor at work	1	0 (−3, 4)	0.788	−2 (−6, 1)	0.210	−3 (−8, 2)	0.267
	4	2 (−3, 6)	0.495	−2 (−6, 3)	0.463	−3 (−9, 3)	0.320
	19	−0 (−4, 4)	0.857	2 (−2, 7)	0.315	3 (−3, 9)	0.373
Sitting at work (min)	1	−19 (−75, 37)	0.503	−64 (−125, −2)	<b>0.049</b>	−44 (−127, 39)	0.302
	4	−30 (−102, 42)	0.421	−76 (−142, −11)	<b>0.027</b>	−47 (−144, 51)	0.354
	19	−18 (−81, 44)	0.568	−100 (−172, −29)	<b>0.009</b>	−82 (−177, 13)	0.100
Standing at work (min)	1	−5 (−53, 42)	0.825	73 (22, 123)	<b>0.008</b>	78 (9, 147)	<b>0.034</b>
	4	1 (−57, 60)	0.972	96 (41, 150)	<b>0.001</b>	95 (15, 174)	<b>0.025</b>
	19	−12 (−65, 41)	0.651	51 (−8, 110)	0.098	64 (−16, 143)	0.125
Walking at work (min)	1	−14 (−36, 8)	0.211	−14 (−38, 10)	0.253	−0 (−32, 32)	0.997
	4	−19 (−47, 9)	0.189	−17 (−43, 8)	0.187	2 (−36, 39)	0.927
	19	−13 (−37, 11)	0.287	−21 (−49, 7)	0.144	−8 (−44, 29)	0.679
Heavy labor at work (min)	1	2 (−16, 20)	0.812	−13 (−33, 7)	0.209	−15 (−42, 12)	0.275
	4	7 (−17, 30)	0.585	−6 (−27, 15)	0.598	−12 (−44, 19)	0.449
	19	−3 (−24, 17)	0.749	11 (−14, 35)	0.396	14 (−18, 46)	0.391
Talk time on call (min)	1	0.1 (−0.7, 0.9)	0.815	−0.5 (−1.3, 0.3)	0.225	−0.6 (−1.7, 0.5)	0.309
	4	0.2 (−0.6, 1.0)	0.646	−0.2 (−1.0, 0.6)	0.606	−0.4 (−1.5, 0.7)	0.491
	19	−0.4 (−1.2, 0.4)	0.324	−0.4 (−1.2, 0.5)	0.413	0.0 (−1.1, 1.2)	0.934
Hold time on call (min)	1	−0.1 (−0.4, 0.2)	0.432	−0.1 (−0.4, 0.2)	0.493	0.0 (−0.4, 0.5)	0.934
	4	−0.3 (−0.6, 0.0)	0.067	−0.2 (−0.5, 0.1)	0.227	0.1 (−0.4, 0.5)	0.679
	19	−0.2 (−0.5, 0.1)	0.196	−0.2 (−0.5, 0.1)	0.204	−0.0 (−0.5, 0.4)	0.968
Wrap up time on call (min)	1	0.0 (−0.8, 0.8)	0.942	0.2 (−0.6, 1.0)	0.574	0.2 (−0.9, 1.3)	0.732
	4	0.6 (−0.2, 1.4)	0.148	0.7 (−0.1, 1.5)	0.091	0.1 (−1.0, 1.3)	0.826
	19	0.7 (−0.1, 1.5)	0.101	−0.1 (−0.9, 0.7)	0.801	−0.8 (−1.9, 0.4)	0.189
Average handling time (min)	1	0.1 (−1.3, 1.4)	0.938	−0.3 (−1.7, 1.0)	0.622	−0.4 (−2.3, 1.5)	0.688
	4	0.6 (−0.8, 1.9)	0.426	0.4 (−1.0, 1.8)	0.619	−0.2 (−2.1, 1.8)	0.846
	19	0.4 (−1.0, 1.7)	0.578	0.0 (−1.4, 1.4)	0.986	−0.4 (−2.3, 1.6)	0.712
Attendance (days)	1	0.2 (−0.6, 1.1)	0.585	0.3 (−0.4, 1.1)	0.407	0.1 (−1.0, 1.2)	0.889
	4	0.5 (−0.3, 1.3)	0.241	0.4 (−0.3, 1.2)	0.272	−0.1 (−1.2, 1.0)	0.890
	19	0.5 (−0.3, 1.3)	0.241	0.6 (−0.2, 1.3)	0.167	0.0 (−1.1, 1.2)	0.938
Sick leave (days)	1	−0.2 (−0.9, 0.6)	0.654	0.2 (−0.4, 0.9)	0.499	0.4 (−0.6, 1.4)	0.436
	4	−0.4 (−1.2, 0.3)	0.247	−0.1 (−0.8, 0.5)	0.666	0.3 (−0.7, 1.3)	0.558
	19	−0.7 (−1.5, 0.0)	0.064	−0.2 (−0.9, 0.5)	0.535	0.5 (−0.5, 1.5)	0.334
Customer rating (%)	1	−25 (−54, 4)	0.098	−9 (−40, 22)	0.571	16 (−27, 58)	0.470
	4	−21 (−50, 7)	0.152	12 (−21, 44)	0.480	33 (−10, 76)	0.140
	19	−10 (−40, 19)	0.492	4 (−29, 36)	0.833	14 (−30, 58)	0.538

**Bold values denote  $p < 0.05$**

the corporate furniture provider, Zenith, who agreed to provide and install sit-stand desks for one team as a free trial; the risk management department monitored the planning and implementation process; the communications department wrote about the trial in the staff

newsletter; and the health and wellness manager coordinated all parties and arranged for the research team to access in-house productivity metrics. At the team level, the team leader of the intervention group was proactive in the study's development phase and attended

**Table 4**  
Self-reported perceptions about work, work-related energy, and feelings at work at baseline, 4, and 19 weeks post-installation of sit-stand desks (intervention), in the Opt to Stand Study, Sydney, Australia.<sup>1</sup>

Question	Control								Intervention							
	Baseline		4 weeks		19 weeks		<i>F</i>	<i>p</i>	Baseline		4 weeks		19 weeks		<i>F</i>	<i>p</i>
	<i>N</i>	Mean (SE)	<i>N</i>	Mean (SE)	<i>N</i>	Mean (SE)			<i>N</i>	Mean (SE)	<i>N</i>	Mean (SE)	<i>N</i>	Mean (SE)		
The physical working conditions at my location are satisfactory	9	3.67 (1.22)	6	3.67 (1.50)	6	3.83 (1.56)	1.58	0.30	8	3.25 (0.37)	10	4.30 (0.13)	5	4.60 (0.13)	3.09	0.11
I am able to sustain the level of energy I need throughout the work day	9	3.22 (1.07)	6	3.00 (1.22)	6	3.83 (1.56)	1.57	0.30	8	2.63 (0.32)	10	3.90 (0.11)	5	3.20 (0.11)	6.44	<b>0.02</b>
I feel positive at work most of the time	9	3.78 (1.26)	6	3.67 (1.50)	6	3.50 (1.43)	1.64	0.28	8	3.25 (0.25)	10	3.70 (0.09)	5	4.00 (0.09)	2.61	0.15
There are no substantial obstacles at work to doing my job well	9	3.56 (1.19)	6	3.50 (1.43)	6	3.67 (1.50)	1.55	0.31	8	3.63 (0.18)	10	3.80 (0.06)	5	4.00 (0.06)	3.46	0.09

<sup>1</sup> Questions were rated from 1 “strongly disagree” to 5 “strongly agree”; mean scores shown here, where a score of “4” means the average was “agree,” or 5 “strongly agree”; increasing scores indicate increasing agreement.

planning meetings prior to trial commencement. The control team was led by two leaders who worked part time and were relatively less engaged and communicated less frequently with the research team. In terms of evidence-based practice, this was a valuable project for the partner organization because the relevance of the setting and resulting data meant a greater level of buy-in from the business. The results have informed an overall strategy to address sedentary work practices across the organization, one that looks at both work environment and behavioral change. Evidence-based strategies are increasingly in demand in Australian businesses to help inform well-being programs, to allocate resources, and to determine return on investment. This partnership between researchers and practitioners has provided an effective model for future cooperation in workplace health promotion.

This study was limited by the small convenience sample, data loss due to activity monitor device malfunction, staff changes over the study period, and participant non-compliance with wearing the devices and/or completing monitoring logs. This data loss due to monitor malfunction could not be easily explained as most of the devices had been used previously without problems and perhaps serves as a reminder for regular maintenance and checks of monitors before starting new studies. Other reasons for loss of data reflect the real-world nature of the Opt to Stand setting: participants were not health-invested nor interested in research per se, and so were potentially more relaxed in their adherence to the study protocol and completion of questionnaires relative to participants in earlier sit-stand desk studies (Pronk et al, 2012; Alkhajah et al, 2012; Healy et al, 2013; Chau et al, 2014a; Neuhaus et al, 2014), despite our efforts to maximize participation in monitoring through an initial face-to-face visit by the project officer and subsequent telephone and e-mail reminders at follow-ups. Social desirability was another potential limitation, in that participants may have wanted to reduce sitting time and increase standing time regardless of their allocation, but this was likely low because control participants showed little change in their behavior. While we found no significant changes in productivity after using sit-stand desks, the likelihood of making a type 1 error remains a possibility due to the small sample size in this pilot study.

In conclusion, Opt to Stand demonstrates that using sit-desks to work in a standing posture does not have negative impacts on productivity, and therefore, sit-stand desks are a feasible strategy for promoting more standing in a real-world workplace setting like a call center. Further research to assess sit-stand desk interventions in other types of desk-bound jobs, larger samples with longer term follow-up, and job-specific productivity outcomes would be important next steps in this area to elucidate the public health potential and impact of sit-stand desks at work.

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.pmedr.2015.12.003>.

### Conflict of interest

AS has received payment from Eli Lilly, the Pharmacy Guild of Australia, Novo Nordisk, and the Dietitians Association of Australia for seminar presentations at conferences. She is also the author of *The Don't Go Hungry Diet* (Bantam, Australia, and New Zealand, 2007) and *Don't Go Hungry For Life* (Bantam, Australia, and New Zealand, 2011).

### Transparency Document

The Transparency document associated with this article can be found, in the online version.

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### References

- Alkhajah, T.A., Reeves, M.M., Eakin, E.G., Winkler, E.A., Owen, N., Healy, G.N., 2012. Sit-stand workstations: a pilot intervention to reduce office sitting time. *Am. J. Prev. Med.* 43, 298–303.
- Brown, W., Bauman, A., Chey, T., Trost, S., Mummery, K., 2004a. Comparison of surveys used to measure physical activity. *Aust. N. Z. J. Public Health* 28 (2), 128–134.
- Brown, W., Trost, S., Bauman, A., Mummery, K., Owen, N., 2004b. Test retest reliability of four physical activity measures used in populations. *J. Sports Med. Sci.* 7 (2), 205–215.
- Chau, J.Y., van der Ploeg, H.P., Dunn, S., Kurko, J., Bauman, A.E., 2012. Validity of the Occupational Sitting and Physical Activity Questionnaire (OSPAQ). *Med. Sci. Sports Exerc.* 44, 118–125.
- Chau, J.Y., Grunseit, A., Chey, T., Stamatakis, E., Matthews, C., Brown, W., Bauman, A., van der Ploeg, H.P., 2013. Daily sitting time and all-cause mortality: a meta-analysis. *PLoS ONE* 8 (11), e80000.
- Chau, J.Y., Daley, M., Dunn, S., Srinivasan, A., Do, A., Bauman, A.E., van der Ploeg, H.P., 2014a. The effectiveness of sit-stand workstations for changing office workers' sitting time: results from the Stand@ Work randomized controlled trial pilot. *Int. J. Behav. Nutr. Phys. Act.* 11, 127.
- Chau, J.Y., Daley, M., Srinivasan, A., Dunn, S., Bauman, A.E., van der Ploeg, H.P., 2014b. Desk-based workers' perspectives on using sit-stand workstations: a qualitative analysis of the Stand@ Work study. *BMC Public Health* 14 (1), 752.
- Church, T.S., Thomas, D.M., Tudor-Locke, C., Katzmarzyk, P.T., Earnest, C.P., Rodarte, R.Q., Martin, C.K., Blair, S.N., Bouchard, C., 2011. Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. *PLoS ONE* 6, e19657.
- Ebara, T., Kubo, T., Inoue, T., 2008. Effects of adjustable sit-stand VDT workstations on workers' musculoskeletal discomfort, alertness and performance. *Ind. Health* 46, 497–505.
- Grant, P.M., Ryan, C.G., Tigbe, W.W., Granat, M.H., 2006. The validation of a novel activity monitor in the measurement of posture and motion during everyday activities. *Br. J. Sports Med.* 40, 992–997.
- Grunseit, A.C., Chau, J.Y., van der Ploeg, H.P., Bauman, A., 2013. "Thinking on your feet": a qualitative evaluation of sit-stand desks in an Australian workplace. *BMC Public Health* 13, 365.
- Healy, G.N., Eakin, E.G., LaMontagne, A.D., Owen, N., Winkler, E.A., Wiesner, G., Gunning, L., Neuhaus, M., Lawler, S., Fjeldsoe, B.S., 2013. Reducing sitting time in office workers: short-term efficacy of a multicomponent intervention. *Prev. Med.* 57 (1), 43–48.
- Hedge, A., Jagdeo, J., Agarwal, A., et al., 2005. Sitting or standing for computer work—does a negative-tilt keyboard tray make a difference? *Proc. Hum. Factors Ergon. Soc. Annu. Meet.* 49 (8), 808–811.
- Husemann, B., Von Mach, C.Y., Borsotto, D., Zepf, K.J., Scharnbacher, J., 2009. Comparisons of musculoskeletal complaints and data entry between a sitting and a sit-stand workstation paradigm. *Hum. Factors* 51 (3), 310–320.
- Karakolis, T., Callaghan, J.P., 2014. The impact of sit-stand office workstations on worker discomfort and productivity: a review. *Appl. Ergon.* 45 (3), 799–806.
- Matthews, C.E., Moore, S.C., Sampson, J., Blair, A., Xiao, Q., Keadle, S.K., Hollenbeck, A., Park, Y., 2015. Mortality benefits for replacing sitting time with different physical activities. *Med. Sci. Sports Exerc.* <http://dx.doi.org/10.1249/MSS.0000000000000621>.
- Neuhaus, M., Eakin, E.G., Straker, L., Owen, N., Dunstan, D.W., Reid, N., Healy, G.N., 2014a. Reducing occupational sedentary time: a systematic review and meta-analysis of evidence on activity-permissive workstations. *Obes. Rev.* 15 (10), 822–838.
- Neuhaus, M., Healy, G.N., Dunstan, D.W., Owen, N., Eakin, E.G., 2014b. Workplace sitting and height-adjustable workstations—a randomized controlled trial. *Am. J. Prev. Med.* 46 (1), 30–40.
- Parry, S., Straker, L., 2013. The contribution of office work to sedentary behaviour associated risk. *BMC Public Health* 13 (1), 296.
- Pronk, N.P., Katz, A.S., Lowry, M., Payfer, J.R., 2012. Reducing occupational sitting time and improving worker health: the Take-a-Stand Project. *Prev. Chronic Dis.* 9, 110323.
- Proper, K.I., Singh, A.S., van Mechelen, W., Chinapaw, M.J.M., 2011. Sedentary behaviors and health outcomes among adults: a systematic review of prospective studies. *Am. J. Prev. Med.* 40, 174–182.
- Ryan, C.G., Grant, P.M., Tigbe, W.W., Granat, M.H., 2006. The validity and reliability of a novel activity monitor as a measure of walking. *Br. J. Sports Med.* 40, 779–784.
- Santos-Lozano, A., Marín, P.J., Torres-Luque, G., Ruiz, J.R., Lucía, A., Garatachea, N., 2012. Technical variability of the GT3X accelerometer. *Med. Eng. Phys.* 34 (6), 787–790.
- Thorp, A.A., Healy, G.N., Winkler, E., Clark, B.K., Gardiner, P.A., Owen, N., Dunstan, D.W., 2012. Prolonged sedentary time and physical activity in workplace and non-work contexts: a cross-sectional study of office, customer service and call centre employees. *Int. J. Behav. Nutr. Phys. Act.* 9 (1), 128–128.
- Torbeyns, T., Bailey, S., Bos, I., Meeusen, R., 2014. Active workstations to fight sedentary behaviour. *Sports Med.* 1–13.
- Troiano, R.P., Berrigan, D., Dodd, K.W., Masse, L.C., Tilert, T., McDowell, M., 2008. Physical activity in the United States measured by accelerometer. *Med. Sci. Sports Exerc.* 40 (1), 181–188 (Jan).
- Van der Ploeg, H.P., Merom, D., Chau, J., Bittman, M., Trost, S., Bauman, A.E., 2010. Advances in physical activity and sedentary behavior population surveillance: reliability and validity of time use surveys. *Am. J. Epidemiol.* 172 (10), 1199–1206.

- Van der Ploeg, H.P., Chey, T., Ding, D., Chau, J.Y., Stamatakis, E., Bauman, A.E., 2014. [Standing time and all-cause mortality in a large cohort of Australian adults](#). *Prev. Med.* 6, 187–191.
- Van Nassau, F., Chau, J.Y., Lakerveld, J., Bauman, A.E., van der Ploeg, H.P., 2015. [Validity and responsiveness of four measures of occupational sitting and standing](#). *Int. J. Behav. Nutr. Phys. Act.* 12, 144.
- van Uffelen, J.G.Z., Wong, J., Chau, J.Y., van der Ploeg, H.P., Riphagen, I., Gilson, N., Burton, N.W., Healy, G.N., Thorp, A.A., Clark, B.K., Gardiner, P.A., Dunstan, D., Bauman, A., Owen, N., Brown, W.J., 2010. [Occupational sitting and health risks: a systematic review](#). *Am. J. Prev. Med.* 39, 379–388.
- WHO/WEF, 2008. Preventing noncommunicable diseases in the workplace through diet and physical activity. WHO/World Economic Forum report of a joint event. World Health Organisation/World Economic Forum, Geneva ([http://www.weforum.org/pdf/Wellness/WHOWEF\\_report.pdf](http://www.weforum.org/pdf/Wellness/WHOWEF_report.pdf)).
- Wilmot, E.G., Edwardson, C.L., Achana, F.A., Davies, M.J., Gorely, T., Gray, L.J., Khunti, K., Yates, T., Biddle, S.J., 2012. [Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis](#). *Diabetologia* 55, 2895–2905.